

**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594**

09-02-2011

SYSTEMS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID No.: CEN11IA156

A. ACCIDENT:

Location:	Galliano, Louisiana
Date:	January 19, 2011
Time:	About 1145 Central Standard Time (CST)
Aircraft:	Sikorsky S-92A
Registration Number:	N920AL

B. SYSTEMS GROUP:

Chairman:	Mike Hauf National Transportation Safety Board Washington, D.C.
Member:	Chris Lowenstein Sikorsky Aircraft Corporation Stratford, CT
Member:	Doug Forslund Bristow U.S. LLC New Iberia, LA

C. SUMMARY:

On January 19, 2011, at 1145 central daylight time, a Sikorsky S-92A helicopter, N920AL, experienced a flight control malfunction during initial descent for landing to Bristow U.S. LLC Galliano Heliport (2LS0), Galliano, Louisiana. Visual meteorological conditions prevailed and a company flight plan was filed for the 14 Code of Federal Regulations Part 135 non-scheduled passenger flight. The three crewmembers and 15 passengers were not injured. The flight originated from an off-shore helipad at Green Canyon 858 in the Gulf of Mexico with 2LS0 as its intended destination.

During the initial approach into 2LS0, as airspeed reduced through approximately 70 knots, the helicopter began a right yaw of more than 100 degrees that could not be stopped by application of left pedal. The crew immediately lowered the nose to regain airspeed and streamline the aircraft. They diverted to the South Lafourche Airport (GAO), Galliano, Louisiana and performed a successful roll on landing, touching down at approximately 72 knots, utilizing differential braking to maintain runway heading.

Upon landing, an inspection by the operator revealed that the tail rotor pitch change beam retention nut and associated hardware were missing from the assembly. Post landing inspection of the tail rotor head assembly revealed that the lock washer and nut from the pitch change shaft along with its associated hardware were missing.

During the on-scene phase of the investigation, the following tail rotor system components were removed from the helicopter and sent to Helicopter Support, Inc (HSI) located in Trumbull, CT.

1. Pitch Change Shaft (P/N 92358-06303-041, S/N B063-00156)
2. Pitch Beam Assembly (P/N 92104-11801-041, S/N A098-00123)
3. Bolts (Quantity 4) P/N 92102-11801-101
4. Washers (Quantity 4) P/N NAS1149C0763R
5. Washers (Quantity 4) P/N NAS1149C0732R
6. Tail Rotor Servo (P/N 92410-06810-105, S/N B034-00112)
7. Bolt T/R/S (P/N 92400-15801-102, S/N B172-00688)
8. Nut T/R/S (MS9364-14)

D. DETAILS OF THE INVESTIGATION:

D.1 Aircraft Information:

The S-92A is a four-bladed, twin-engine, medium-lift helicopter built by Sikorsky Aircraft Corporation for the civil and military helicopter market. The civil transport version has an airliner-type interior which seats up to 19 passengers. The incident aircraft was manufactured in July of 2008 and delivered to Bristow U.S. LLC on October 4, 2008. This helicopter was configured with 21 seats; 19 of these seats were passenger seats located in the main cabin. The helicopter's most recent continuous airworthiness inspection was conducted on January 17, 2011 at an aircraft total time of 1,243.8 flight hours. At the time of the incident, the aircraft's total time was 1248.3 flight hours. A review of Bristow U.S. LLC's maintenance records revealed that at about 4.8 flight hours prior to the mishap the pitch change shaft had been replaced due to a scheduled 1,250 flight hour maintenance requirement.

D.2 Tail Rotor System Description:

The tail rotor is a bearingless controllable pitch system requiring no lubrication. Four blades attached to a titanium rotor head assembly provide directional control of the aircraft and counteract the torque produced by the main rotor. The tail rotor blades are constructed of graphite and fiberglass, with a nickel erosion strip leading edge, and adjustable balance weights. The tail rotor is canted 20° providing 4% of total lift to the helicopter during hover operations. Blade pitch is changed by servo action through a pitch beam through links to a pitch horn attached to each blade. Flexbeams that attach each of the rotor blades to the rotor hub enable the blades to change pitch and flap. Tail rotor pitch change and blade flap are accomplished by twisting the flexbeam, causing the blades to change pitch. The tail rotor head transfers pitch inputs from the tail rotor servos to the blades. It consists of a hub, four arm pitch beam and four pitch links. The rotor hub is attached to and rotates with the tail rotor shaft. The four blades are bolted directly to the hub at a 90° angle from each other. The four arm pitch beam applies pitch to the rotor blades through the pitch links. The pitch beam is directly attached to the tail rotor servo output linkage. The tail rotor pitch control links connect the pitch horn on each blade to the pitch beam. When the pitch beam moves in response to tail rotor servo motion, the pitch control links transfer the motion to the blades, causing them to twist and change pitch.

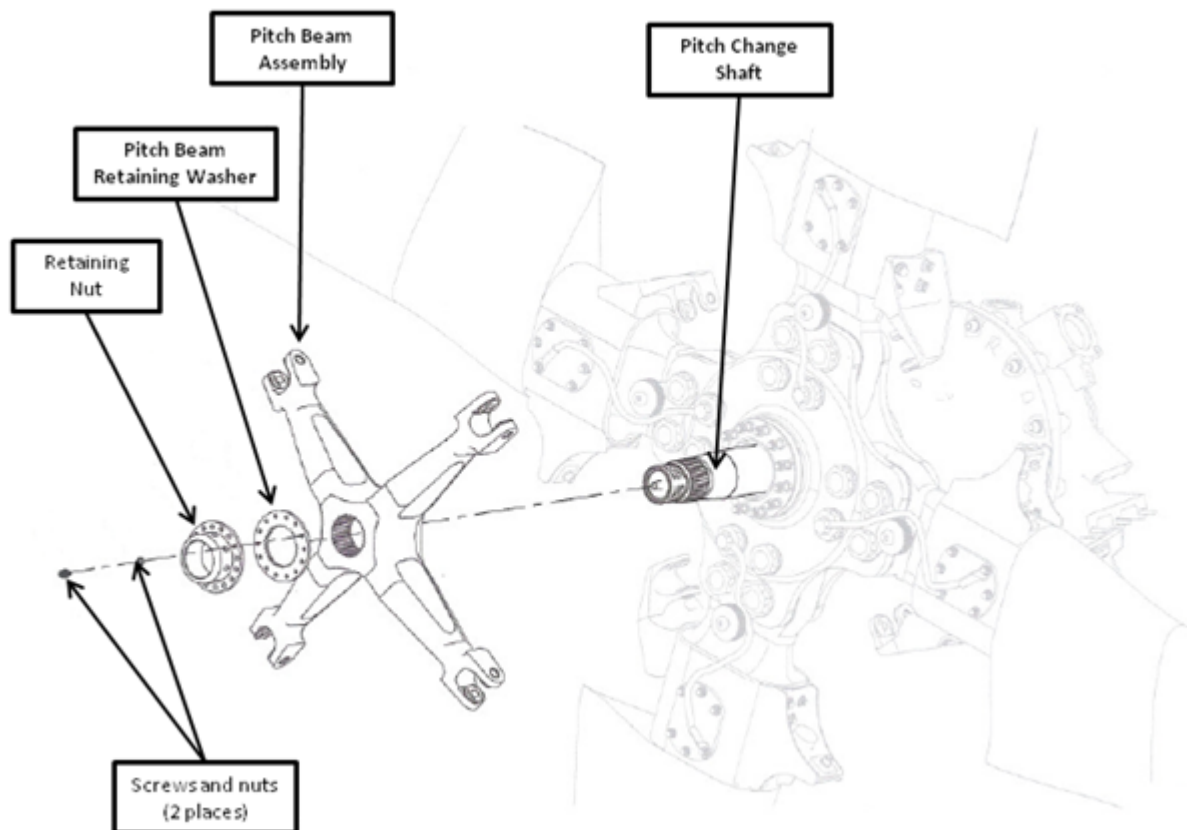
D.3 Installation of the Tail Rotor Pitch Beam Assembly:

A review of the Sikorsky Aircraft Maintenance Manual (SA S92- AMM-64-22-01) titled "Tail Rotor Pitch Beam Assembly – Maintenance Practices", dated December 10, 2010, found that the procedure included the following steps to install the tail rotor pitch beam assembly (Figure 1):

1. Slide tail rotor pitch beam on tail rotor pitch change shaft.
2. Check alignment of tail rotor pitch beam and pitch change shaft splines. Make sure wide tooth and wide space in splines are lined up.

3. Install pitch beam washer on tail rotor pitch change shaft. Make sure wide tooth and wide space in splines are lined up.
4. Using pitch beam nut wrench, install retaining nut on tail rotor pitch change shaft.
5. Measure and record prevailing torque of retaining nut.
6. Torque retaining nut to minimum of 183 foot-pounds plus prevailing torque.
7. Increase torque until holes in pitch beam washer and retaining nut line up for screws.
8. Do not exceed 202 foot-pounds plus prevailing torque.
9. Install screws and washers in retaining nut.
10. Torque screws to 10 - 40 inch-pounds.

Figure 1 Tail rotor assembly



On February 14, 2011, Sikorsky Aircraft Corporation issued a temporary revision to SA S92-AMM-64-22-01. This revision modified the procedure to install the tail rotor pitch beam assembly by including additional instructions and figures to more clearly describe critical instructions. The additional instructions include marking the outside of the pitch beam and pitch beam locking washer in line with the wide tooth spline on each part. After assembly operators can now ensure the wide tooth spline of the locking washer and pitch change shaft are aligned. Checks were added after installation to ensure there is no gap between mating parts and ensure proper pitch change shaft thread protrusion from the end of the retention nut. Figures were added to show what the correct installation should look like, that no gaps are allowed, and the proper thread protrusion

D.4 Component Examinations:

On January 24, 2011, the Systems group convened in Trumbull, Connecticut at the HSI facility. Under the observation of the NTSB, the shipping containers were opened and the tail rotor system components were removed, tagged and photographed. The components were then re-packaged and transferred, via the NTSB, to the Sikorsky Aircraft Company Materials and Processes laboratory for examination.

D.4.1 Pitch Change Shaft:

The pitch change shaft part number 92358-06303-041, serial number B063-00156 was examined at the Sikorsky Aircraft Company Materials and Processes laboratory. Refer to figure 2 for a photograph of the pitch change shaft after it was removed from the helicopter.

Figure 2 As-received pitch change shaft



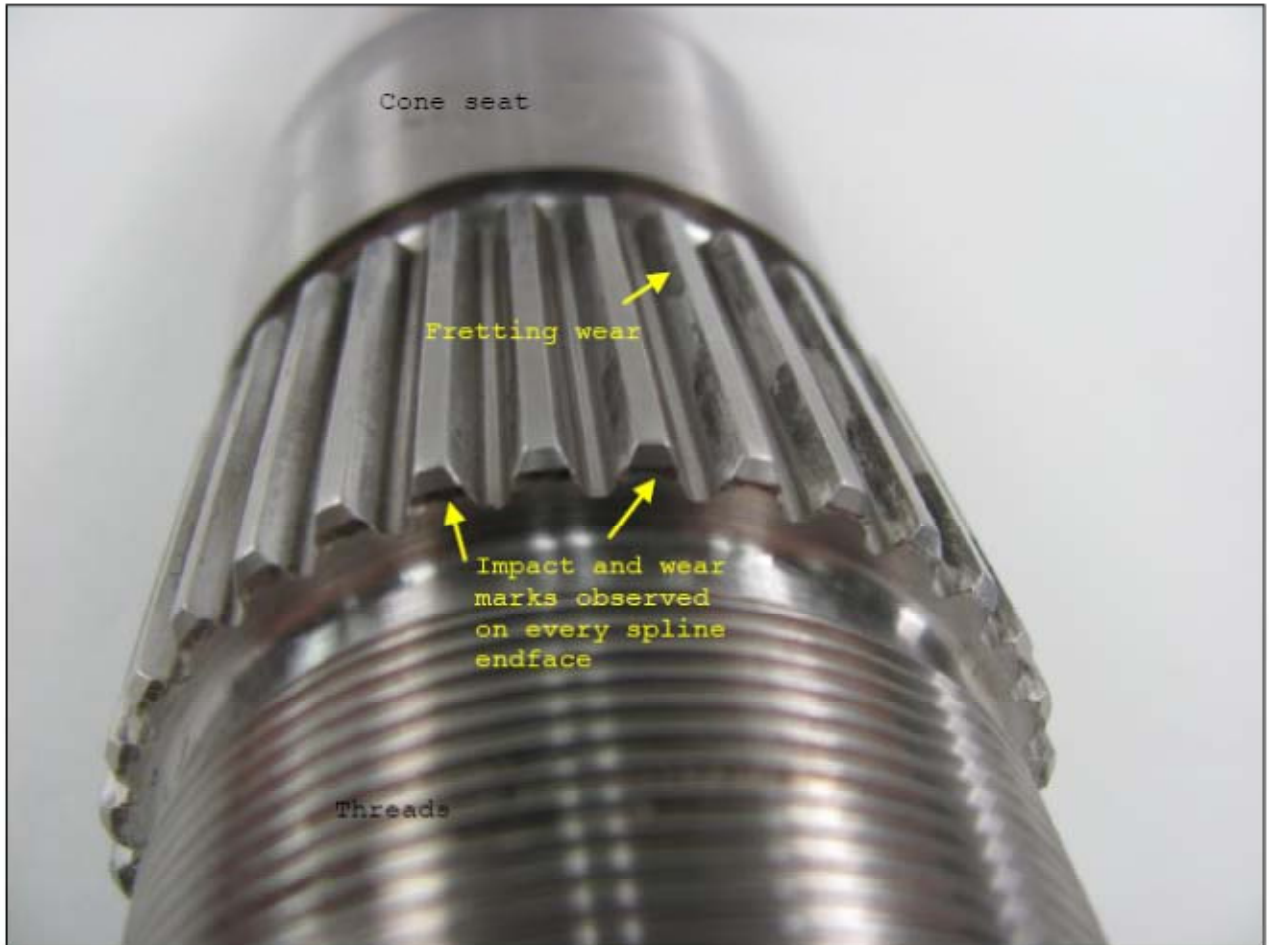
A magnetic particle inspection (MPI) on the pitch change shaft did not reveal any cracks. The threads of the pitch change shaft appeared to be in good shape with the exception of a few threads with evidence of fretting wear (Figure 3) on the engaging surfaces. Dimensional inspection of the threads showed that the locations without fretting damage met the required drawing specifications.

Figure 3 Pitch change shaft - fretting wear on threads



Plastic deformation marks (consistent with the shape of the washer splines) were observed on the end faces of all of the pitch change shaft splines. Refer to figure 4. Adjacent to the compressed spline outlines were wear marks.

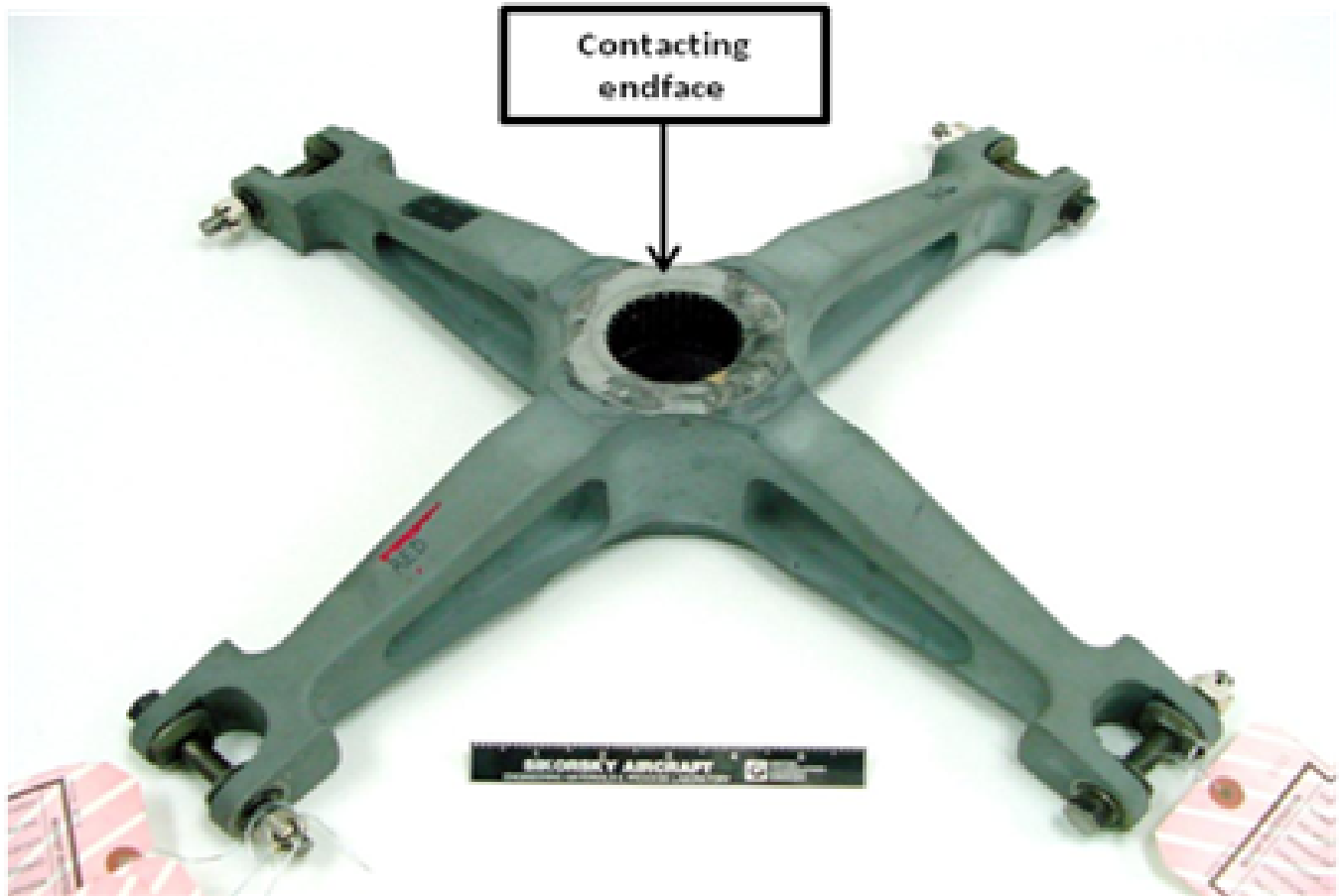
Figure 4 Pitch change shaft - impact marks on spline end face



D.4.2 Pitch Beam Assembly:

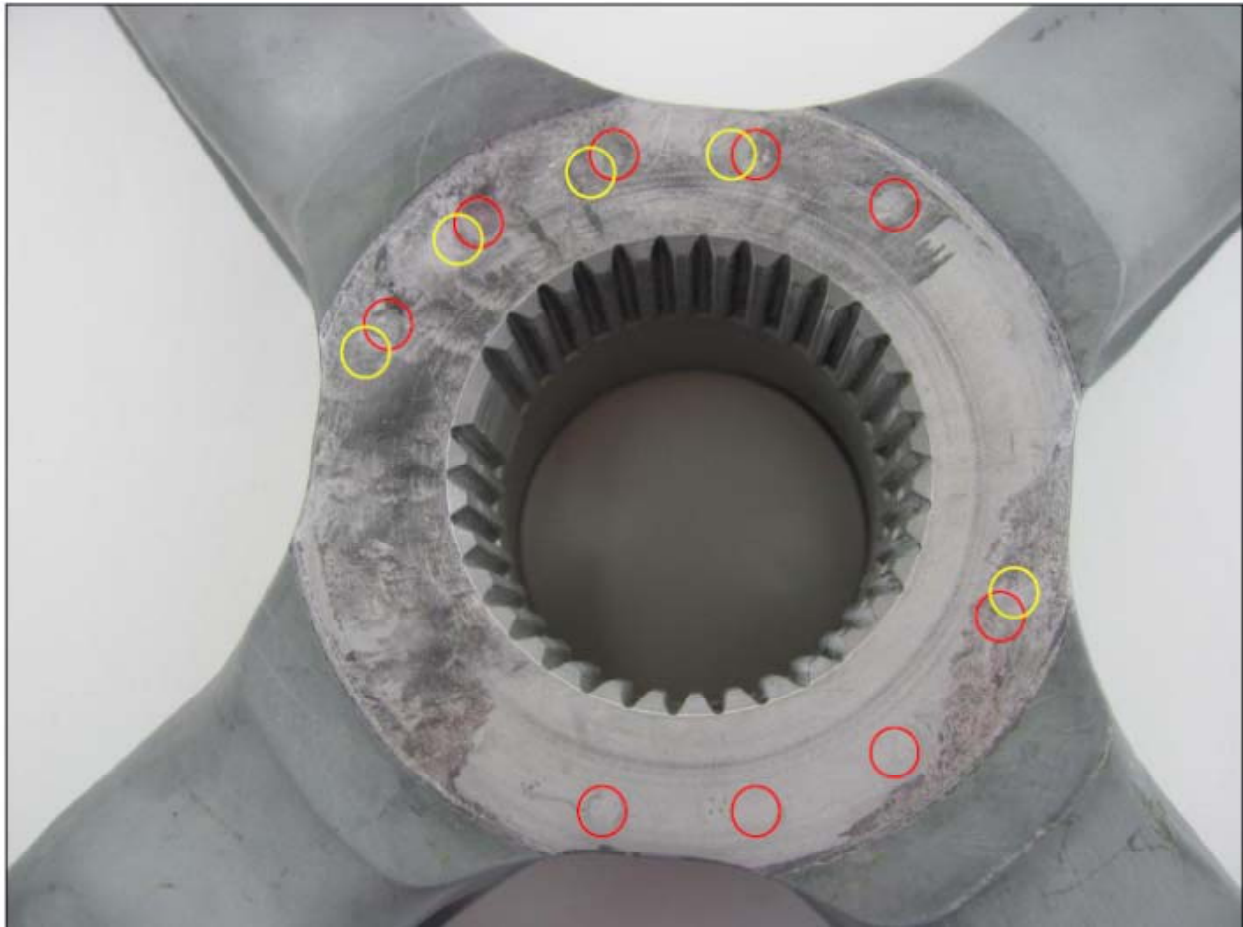
A cursory visual examination of the pitch beam assembly (Figure 5) revealed witness marks (which appear to be consistent with imprints of spline teeth) within the inner diameter of the component.

Figure 5 Pitch Beam Assembly



Two sets of witness marks from the screw holes of the missing pitch beam lock washer were visually observed on the contacting end face of the pitch beam assembly. Refer to figure 6.

Figure 6 Witness marks on the pitch beam assembly



An exemplar pitch beam lock washer was placed in contact with the pitch beam and the two sets of witness marks independently lined up with the holes in the washer. In both configurations the large tooth of the washer and the large tooth of the pitch beam did not line up. The evidence of the witness marks along with the plastic deformation on the end faces of the pitch change shaft splines is consistent with the locking washer installed with its indexing spline slightly off, resulting in a cocking condition and incomplete engagement of the spline teeth.

D.5 Sikorsky Alert Service Bulletin 92-64-007:

On February 09, 2011, Sikorsky Aircraft Corporation issued Alert Service Bulletin 92-64-007 to provide all operators of S-92A model helicopters with instructions to perform a one-time visual inspection of the tail rotor pitch beam retaining nut installation. According to the bulletin, the visual inspection includes a check for thread protrusion of the pitch change shaft above the tail rotor pitch beam retaining nut. If thread protrusion is present, no further action is required and helicopter can be returned to service. If thread protrusion is not present, a further check for any gap between the tail rotor pitch beam assembly and the pitch beam washer should be performed. If thread protrusion is not present or if any gap between the tail rotor pitch beam assembly and pitch beam washer is found, Sikorsky Aircraft must be contacted before further flight for evaluation and disposition of affected the components. This one-time inspection shall be accomplished within 10 flight hours or 30 days from the issue of the Alert Service Bulletin.

Mike Hauf

Aircraft Systems Engineer